Earth System Science Research:

Development of Predictive Models Using Remotely Sensed Data for Simulating Damage Potentials to Natural Resources in the Southeastern United States

(Progress Report April 1995 - May 1996)

Partnership between NASA Earth Science and Application Division and North Carolina A&T State University

Submitted by

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Principal Investigator

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FAX (910) 334-7399

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Results from Prior NASA Support

Project Title: Development of Predictive Models Using Remotely Sensed Data for Simulating Damage Potentials to Natural Resources in the Southeastern United States

Grant No.: NAG-1-1454

Period: October 1, 1992 - June 30, 1996

Amount: $353,457

Introduction:

North Carolina A&T State University offers an undergraduate degree (B.S. option) in Earth and Environment Sciences and a graduate degree (M.S.) in Plant and Soil Science. The University has also B.S. and M.S. programs in engineering and general engineering (agricultural and civil) with emphasis on water resources and environmental engineering. North Carolina A&T State University is committed to developing a comprehensive program in Earth System Science (ESS) focused on innovative, "cutting edge" research in conjunction with the development of student scholars. The ESS research component is intended to pursue research initiatives to support NASA's "Mission to Planet Earth," EOS project contribution to the U.S. global research programs.

Earth System Science Research (Coordinated by E.U. Nzewi)

The development of an Earth System Science Research Laboratory is almost complete. The laboratory is being developed for analysis and interpretation of remotely sensed environmental and natural resources data, development of models, validation of models along with statistical predictions of future environmental and natural resources changes. Acquisition of the following computer hardware for a Hewlett Packard (HP) 715/50 for a GIS/RS workstation is complete. The hardware includes a powerful HP 64 MB RAM Computer (HP 715/50 color 2D/D), 19" Monitor, Macintosh IISI Computer, G6-150 Gateway Computer System, Power Macintosh 7100/80, LaserWriter Pro and Demo Bundle, 2 Laser Writters, optional Hardware modules (DAT drive, CD-ROM drive, 1.44 Floppy Drive) for facilitation of

software installation/data acquisition and accessories. Computer software for the GIS/RS Workstation includes: GenaMap for geographic analysis and modeling, EASI/PAC for image processing, 4D for database management, compliers for development of custom computer programs, Map Info and Map Basic for GIS research. Students are involved in the demonstration of the above software packages. The EES laboratory is completely wired for e-mail, internet, worldwide web, and homepage.

Linwood Peele, a graduate student (M.S.) in Civil Engineering, is completed a thesis project entitled, "Integrating GIS/RS in the Assessment of Hydrogeological Vulnerability of Aquifers in the SE United States." The thesis summary is in the Appendix.

Graduate Students

Linwood Peele (African-American male) is a civil engineering major (M.S.). He has completed his thesis work. His thesis deals with the development of vulnerability indices for use in classification of contaminated aquifers in the North Carolina Piedmont. Linwood received his M.S degree in Civil Engineering, May 1995.

Angelique Wheelock (White female) is a Land Use and Environmental Management major (M.S.). Angelique was supported in the Spring Semester, 1993. The subject of her M.S. thesis is "The Analysis and Interpretation of Remotely Sensed Agricultural Resource Data (Soils, Water and Vegetation Changes)". Ms. Wheelock has withdrawn from the University for personal reasons.

Broadus E. Funderburk (African American Male) is an earth and environmental science major. Broadus is working on the "GIS Analysis of Potential Waste Sites in the S.E. United States".

Renessa Hardy (African American Female), is a soil and environmental science major. She is interested in the Biological Systems of the earth. She will complete her M.S. degree in summer 1996.

Undergraduate Students

Eulanda Grigg (African-American female), an Earth and Environmental Science graduate (B.S.). She received her B.S. degree in Earth and Environmental Science in May 1995. Eulanda is interested in learning how the earth operates. She was involved in the EES/EOS research activities.

Harvey Campbell (African-American male), an Earth and Environmental Science graduate (B.S.). He received his B.S. degree in Earth and Environmental Science in May 1996. Harvey was involved in the development of GIS/RS workstation.

Alecia Steele (African-American female), a Civil Engineering graduate. She was initially supported in the Summer of 1993. She is involved in water resources research. Alecia graduated with a B.S. degree in Civil Engineering in May, 1994.

Wilfred Nixon (African-American female), an Earth and Environmental Science graduate (B.S.). He graduated in May 1996. Wilfred is interested in computer modeling of the earth system.

Kelvin Jordan (African-American male) is a junior in the Civil Engineering program. He assisted with information gathering for earth system research.

Damon Martin (African-American male), a Civil Engineering graduate. He graduated in May 1996. He has a strong interest in computer modeling of the earth system.

Travis Chapman (African Amarican Male), graduated with a B.S. degree in Earth and Environmental Science in May 1996. Travis was interested in Microbial Ecosystems.

Earth Systems Science Curriculum Development (Coordinated by G.A. Uzochukwu)

North Carolina A&T State University implemented an earth system science course in the Fall Semester, 1992. Fourteen advanced undergraduate and graduate students enrolled in the course in the Fall of 1992. The course was taught for the 2nd time in the Fall of 1994. Course materials are discussed in the Appendix. A total of 14 advanced undergraduate and graduate students were enrolled in the course.

Two courses entitled, "Water Resources Engineering (7 graduate students) and Hydraulics (20 advanced undergraduate and graduate students) were taught in the Department of Civil Engineering in Fall Semester, 1994. A new course in GIS/RS were developed in the Department of Civil Engineering. The laboratory component of the courses takes into account instructional activities that involve at least 10 students. Other EES courses enhanced include: EASC 201 - Earth Mans' Environment, CIEN 360 - Hydrology, CIEN 560 - Water Resources, and AGEN 701 - Soil & Water Cons.

Earth Systems Science Precollege Outreach (Coordinated by G.A. Uzochukwu)

This project involves a precollege outreach activity. This is necessary to prepare students for undergraduate education in Earth System Science. One hundred students (Sixty precollege and forty college) were involved in a summer workshop in July 1994 and 1995. The workshop was entitled "Waste Management". This was a way to demonstrate the consequences of human impact on the earth system. Twelve public school teachers participated in an earth and environ. sci. summer institute in June 1995.

Detailed Work Plan (FY 96/97)
Earth Observing System and Earth System Science (ESS) Activities:

The objectives of the Earth System Science activities are as follows:

1. Continue the development and upgrading of the ESS research laboratory.

2. Complete graduate student research (GIS Analysis of Waste Sites)

3. Enhancement of EES courses

4. Develop courses in remote sensing with GIS as the environment for its implementation

5. Sponsor outreach projects in earth science for precollege students/teachers.

Technical Approach

Earth System Science Research

The research would identify and map potential waste sites for spread of pollution in S. E. United States using GIS. Predictive models will be used for environmental remediation. A physical scale model will be developed to better understand the fate and transport of pollutants in porous and non-porous media.

Earth System Science Instruction:

Earth System Science research will enhance our teaching programs at both undergraduate and graduate levels by involving students in research activities and providing the needed expertise for developing courses in ESS. A comprehensive course (GEEN 789 - Geographic Information System, GIS) which covers remote sensing/GIS topics relevant to research was developed and taught in the fall of 1995. The ESS research laboratory takes into account instructional activities which will involve 10 students. Therefore, adequate computer nodes for 10 students are included in the ESS laboratory plan. The GIS/Remote Sensing objectives will be concurrently met. Therefore, research and instructional software for both areas are being acquired at the same time. The following EES courses (EASC 666 - Earth System Science, CIEN 560 - Water Resources, CIEN 360 - Hydrology, AGEN 701 - Soil and Water Conservation, EASC 309 - Physical Geology) were enhanced to meet the needs of NASA's Mission to Planet Earth.

Earth System Science Precollege Outreach:

A field trip to the Grand Canyon involving precollege students and teachers was sponsored on June 17-24, 1995. The trip will be co-sponsored by the Greensboro Area Mathematics and Science Education Center (GAMSEC), A&T Foundation, and the Waste Management Institute at North Carolina A&T State University. The purpose

of the trip was to provide precollege students and teachers the opportunity to learn how the earth system works and also prepare precollege students for undergraduate education in Earth System Science. More outreach activities are planned for the future.

Time Schedule:

June 1996 to May 1997

- GIS Research
- Completion of EES Laboratory
- EES Curriculum Enhancement
- EES Outreach for Public Schools

EES Publications:

- Earth and Environmental Science Curriculum Flyer
- Earth Observing System Flyer
- Employment Opportunities in EES Field

EES Research Agencies/Cooperators:

- North Carolina A&T State University (Department of Natural Resources and Environmental Science (Earth Science), Civil Engineering, Chemistry, Biology)
- NASA
- USDA-SCS
- UNC-Chapel Hill
- NC Department of Environment and Natural Resources
- Penn State University
- County and Municipalities of Areas Affected by Hugo
- Selected High Schools and Middle Schools

Appendix

Thesis Summary
EES informational Materials
EES Instructional Materials
EES outreach Materials
Resumes of Investigators

EOS RESEARCH PROGRAM
M.S. Thesis Summary - Linwood Peele

As the generation of hazardous waste increases, so does the transportation of hazardous waste thus increasing the potential of accidents severe enough to result in the contamination of groundwater sources. With a significant portion of the Southeastern United States population depending upon groundwater for potable water, the contamination of aquifers is a problem that needs attention. In this study, Geographic Information System (GIS) technology was exploited in coordination with the use of remote sensing imagery, to examine the hydrogeological vulnerability of aquifers in the vicinity of hazardous waste generation sites and transportation corridors. The major objective of this research was to develop a tool to identify vulnerability indices for known groundwater sources. These indices indicate the level of threat to groundwater in the areas studied. The modeling technique include an integrated GIS model to develop a management system which may be used to select sites for hazardous waste disposal and transportation routes which minimize risk to groundwater contamination.

Suggested Curriculum in Earth and Environmental Science
(124 - 128 Cr. Hrs. for Graduation)

Science for Practical Benefits

Godfrey A. Uzochukwu, Ph.D., Professor
Coordinator

Freshman Year

First Semester	*Credit*	*Second Semester*	*Credit*
ENGL 100	3	ENGL 101	3
HIST 100	3	HIST 101	3
MATH 111	4	MATH 112	4
PHED 101	1	PHED 102	1
CHEM 106	3	CHEM 107	3
CHEM 116	2	CHEM 117	2
	16		16

Sophomore Year

First Semester	*Credit*	*Second Semester*	*Credit*
ENGL 200	3	ENGL 201	3
EASC 201	3	*Electives (Major Area)	4
BIOL 221	4	EASC 309	3
NARS 110	3	MATH 224	3
SPCH 250	3	GEOG 200	3
	16		16

Junior Year

First Semester	*Credit*	*Second Semester*	*Credit*
CHEM 221	3	*Electives (Major Area)	3
CHEM 223	2	EASC 433	2
PHYS 225	3	EASC 408	3
PHYS 235	1	Major electives (Major Area)	3
SLSC 338	4	SLSC 621	4
EASC 622	3	EASC 444	1
NARS 520	1		
	17		16

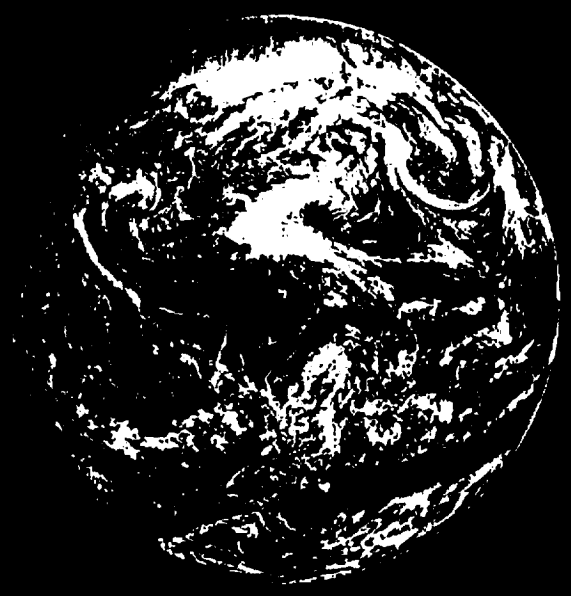
Senior Year

First Semester	*Credit*	*Second Semester*	*Credit*
EASC 616	3	EASC 666	3
EASC 624	3	EASC 699	3
SLSC 634	4	*Electives (Major Area)	3
SLSC 633	4	Elective (Non Major)	5
*Electives (Major Area)	3		
	17		14

**Major Electives:*

EASC 625, EASC 644, EASC 330, BIOL 621, CIEN 310, CIEN 618, AGEN 401, HIST 210, HIST 322, SLSC 609, EASC 627, SLSC 632, CHEM 222, CHEM 224, PHYS 101, FORS 618, AREN 221, HIST 307, BUAD 341, ANS 637, CM 593, OSH 311, OSH 312, OSH 411, OSH 413, AGED 607 and approved consortium courses. These courses must be approved by the advisor.

Courses are described in the University Catalog.



- Geographic Information Systems
- Remote Sensing
- Earth System Science
- Space Studies
- Land Resources
- Biogeochemical Cycles
- Water Resources
- Climatic Changes
- Atmospheric Systems
- Waste Disposal
- Pollution
- Pollutants
- Earth & Medical Sciences
- Earth Movements
- Earth Hazards
- Energy Resources
- Environmental Planning
- Ecological Restoration
- Environmental Restoration
- Environmental Management

Earth and Environmental Sciences

Sciences For Practical Benefits

Undergraduate Curriculum (B.S.)

NORTH CAROLINA A&T STATE UNIVERSITY

Greensboro, North Carolina

Employers

Mining Industry
Department of Agriculture
Department of Interior
Department of Defense (Army)
Environmental Protection Agency
Department of Energy
NASA (Space Agency)
NRC (Nuclear Agency)
Academia
Consulting Industry
Developers
Banks
Real Estate Industry
Attorneys
State & Local Environmental Planners and more!

For More Information

CURRICULUM/FINANCIAL AID
Earth and Environmental Science Curriculum
Dept. of Natural Resources & Environmental Design
NC A&T University
Greensboro, NC 27411
(910) 334-7779 • FAX (910) 334-7844

ADMISSION
Office Of Admissions
Dowdy Building
NC A&T University
Greensboro, NC 27411
(910) 334-7946

Funded by NASA and USDOE- SR

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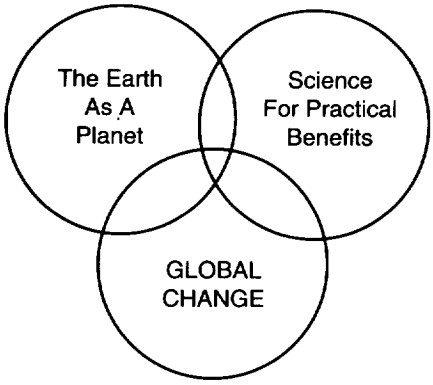
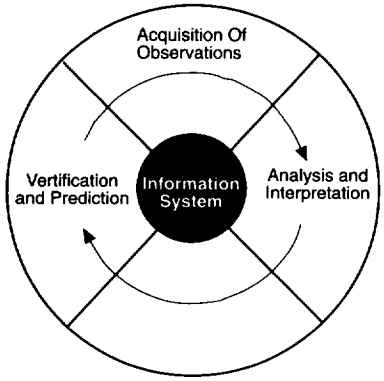
OBSERVING SYSTEM

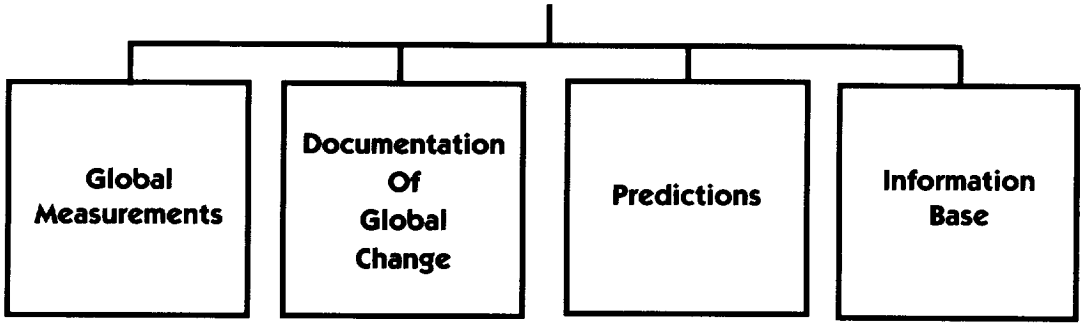
NORTH CAROLINA A&T STATE UNIVERSITY
Greensboro, North Carolina





- Geographic Information System (GIS) and Remote Sensing (RS) Technologies for management of natural resources and environmental protection.
- GIS and RS emphasize data collection, analysis interpretation, data structures, expert systems, statistics, graphics display and modeling.
- Communications of GIS and RS data to users in a meaningful form.
- Earth System Science Instruction and Community Outreach.

ANTICIPATED ACHIEVEMENTS



For More Information Curriculum And Financial Aid

EASC Curriculum
Department of Natural Resources and Environmental of Design
NC A&T State University
Greensboro, N.C. 27411
(910) 334-7779 • FAX (910) 334-7844

Water Resources Engineering
Department of Civil Engineering
NC A&T State University
Greensboro, N.C. 27411
(910) 334-7737 • FAX (910) 334-7667

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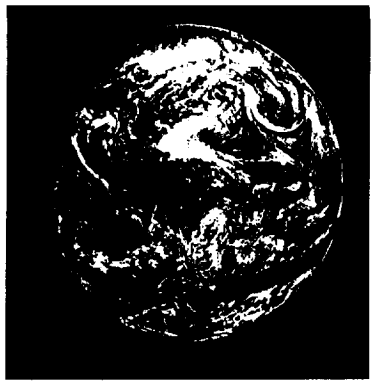

Earth & Environmental Sciences

Management

- Data Management
- OA/OC Services — EPA OAMS
- Environmental/OSHA Training
- Community Relations — Right to Know
- Regulatory Compliance & Permitting
- Site Assessments/ Environmental Audits
- Environmental Safety & Health Training
- Environmental Safety & Risk Assessment
- Underground Storage Facility Management
- Environmental Monitoring — Air/Land/Water
- Storm Water Management & Permitting — NPDES
- Remedial Investigations & Feasibility Studies (RI/TS)
- Hazardous, Radioactive & Mixed Waste Management
- Environmental Equity Investigations & Support Services
- RCRA Facility Investigations/Corrective Measures Studies (RFI/CMS)

Support Services

- Underground Storage Tank Assessments
- Air Permitting
- Waste Minimization Studies
- Mixed Waste Characterization
- Hazardous Waste Site Management
- Storm Water Run-Off Permitting
- Visible Emissions Evaluations
- NPDES Permitting
- RCRA Compliance & Permitting
- CERCLA/SARA Compliance & Assessments
- Environmental Audits
- Comprehensive Environmental Compliance Audits
- Environmental Assessments
- Environmental Impact Statements
- Regulatory Compliance
- Remedial Investigations
- Risk Assessments
- Emergency Planning, Training, & Exercises
- Safety and Transportation Regulatory Compliance & Assessment
- Radiological and Hazardous Materials Response Training
- Site Investigations/Feasibility Studies
- **Field Operations:**
  - Sampling of Groundwater, Surface Water, Soil & Rock
  - Hydrogeological Modeling
  - Geophysical Surveys
  - Geochemical Surveys

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Department of Natural Resources and Environmental Design
NC A&T State University

Earth and Environmental Science Curriculum

EASC 666 - Earth System Science 3 credit hours

Instructors: G. A. Uzochukwu, Ph.D. and the Earth System Science Team
224 Carver Hall
334-7779

Prerequisites: Consent of the Instructor

Course Text: Prepared Handouts/Technical Papers

Course Description:

Study of the Earth as a "System" with emphasis on the Atmosphere, Biosphere, Hydrosphere and Lithosphere interactions in relation to global climate change and human activities, including environmental sustainability, transformation, and earth system modeling.

Topics:

1. Introduction

   (a) Science as a way of thinking
   (b) Systems approach to problem solving
   (c) Earth System Components
   (d) Contributions to humans from the earth system.

2. Earth System History

   (a) Mass extinctions and bolide impacts
   (b) Paleoclimates and paleoecology
   (c) Atmospheric composition
   (d) Hydrologic systems
   (e) Sudden geologic events (extinction and evolution)
   (f) Solar evolution and climate stability

3. Solid Earth Processes

   (a) Plate tectonics
   (b) Crustal motions (volcanism and earthquakes)
   (c) Soil dynamics
   (d) Erosion and mineral composition of exposed rocks and soils

4 Ecological Systems and Principles

   (a) Bio-consequences of global change (aquatic and terrestrial)
   (b) Interaction between physical and biological processes
   (c) Population and capital in the global ecosystem

5. Biogeochemical Dynamics

   (a) Nutrient cycling
   (b) Fluxes of gases and nutrients
   (c) Biochemistry of surface and deep water

6. Global Change and Human Interactions

   (a) CO_2 reservoirs
   (b) Greenhouse effect and greenhouse gases
   (c) Ozone layer depletion
   (d) Radioactive environment
   (e) Waste and pollution
   (f) Deforestation
   (g) Changes in landuse

7. Environmental Transformation Concerns

8. Environmental Sustainability

9. Earth System Research/Modeling

10. Student Presentations

Course Guideline for Earth Science 666
Earth System Science

Instructor: G. A. Uzochukwu, Ph.D.

Office Hours: Will be announced in class.

Grading:

2 major exams	50%
Comprehensive final exam	25%
Projects	25%
	100%

Examinations: Exam format will be mostly essay questions. All students must present at the scheduled exam time.

Projects: All late projects will be subject to rejection.

Attendance: Regular attendance is required for obtaining maximum value from the course. More than 3 absences are considered excessive.

Eating, drinking, smoking, etc. are not allowed in the classroom.

Academic Honesty: Academic honesty is expected at all times.

Grading Policy:

90 - 100 = A
80 - 89 = B
70 - 79 = C
60 - 69 = D
<60 = F

Earth Science 666 Earth System Science
Special Project

Ten page double-spaced typed paper
Title page (See attached)
Table of contents with page numbers
Numbered pages

Objectives
Discussion
Conclusions
References/Bibliography
Others

Project Due Date: Nov. 15, 1994 at class time.
Late projects will be rejected.

Bibliography/References (Format)

1. Hileman, B., 1982. Herbicides in Agriculture. Environ. Sci. Technol. 16: 645-650.

2. Mount, D.I. and W.A. Brungs. 1967. A simple dosing apparatus for fish toxicology studies. Water Res. 1: 21-29.

3. Rodgers, C.A. 1970. Uptake and elimination of simazine by green sunfish (Lepmis cyannellus R.) Weed Sci. 18: 134-136.

Title of Paper:

Author:

Evaluation	Max. Points	Points Awarded
Organization	10	
Length	5	
Discussion	20	
Content	40	
Word Use, spelling, etc.	10	
References/Bibliography	10	
Neatness	5	

NORTH CAROLINA A&T STATE UNIVERSITY

Department of Civil Engineering

CIEN 662 WATER RESOURCES ENGINEERING **Fall 1994**

Course Information

Please keep this information for your reference. **8/20/94**

Instructor:	***Dr. Emmanuel U. Nzewi***
Lecture Location:	Mon, Wed: 10:00 -11:15 AM; Room 312, McNair Hall
Office:	503 McNair Hall
Office Hours:	Mon & Wed (See posted Times); Tue 8:30 - 2:30 PM
Telephone:	(910) 334-7737
Computer addresses:	ce360@garfield.ncat.edu and nzewi@garfield.ncat.edu
Textbook:	*Gupta, Ram S.*, Hydrology & Hydraulic Systems, First Edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1989. **Handouts will also be provided when necessary.**
Reference Texts:	• McGhee, T. J., *Water Supply & Sewerage*, 6th Ed., McGraw-Hill, New York, 1991. • **Linsley, Franzini, Freyberg & Tchobanoglous, *Water Resources Engineering*, 4th Edition., McGraw-Hill, 1992** • Ponce, V., *Hydrology: Principles and Practices*, 1st Ed., Prentice-Hall, 1989 • Bedient & Huber, *Hydrology and Floodplain Analysis*, 2nd Ed., Addison-Wesley, 1992 • Morris & Wiggert, *Applied Hydraulics in Engineering*, 2nd Ed., John Wiley, 1972.
Course Description:	To present the design of water resource systems, water law, and water resources planning and management.
Computer Usage:	Students should be able to use computer programs on the UNIX/DOS /Mac machines.

Fall 1994 Semester Calendar & REMINDERS

Aug 26 Fri	Last day to ADD a course or receive full credit for DROPPING a course
Aug 26 Fri	Last day to audit a course
Aug 22 Mon	Classes Begin !! -- Start strong & finish strong!
Sept 5 Mon	Holiday - Labor Day
Sept 6 Wed	Last day to apply for Fall Semester 1994 graduation
Sept 26 Mon	Exam #1 -- Room 312, McNair Hall
Oct 3 Mon	Deadline to remove Spring 1994 incompletes
Oct 15 - 18	Fall Break!! Begins at 12 Noon
Oct 27 Thur	Last day to DROP a course without grade evaluation /Founders Day
Nov 8 Tue	Last day to WITHDRAW from the University without a grade evaluation
Nov 21 Mon	Exam #2 -- Room 312, McNair Hall
Nov 23 - 27	Thanksgiving Holidays begin 1:00 PM
Dec 7 Wed	Final Project Presentation [Classes End!]
Dec 8 Thurs	Reading day!
Dec 9-16	Final Exams Period
Dec 13 Tue	Final Project Due 10 AM SHARP! in Room 503 McNair Hall
Dec 19 Mon	Grades due @3:00 P.M. in Registrar's office

Course Guidelines

1. There will be 2 hour exams and design projects
2. Homework assignments will be collected and graded. There will be about eight to twelve assignments during the course of the semester including design projects. NO LATE HOMEWORK /ASSIGNMENT WILL BE ACCEPTED (GRADE = 0).
3. The course grade will be determined as follows:

Exam #1	30%
Exam #2	35%
Design Projects	20%
Homework	15%
Total	**100%**

4. Dishonesty will result in a grade of F (or ZERO) for the assignment or test involved.
5. Students are expected to attend all class sessions. The University believes that students themselves are primarily responsible for attendance.
6. Standard 8 1/2" X 11" Engineering paper should be used for homework. Work should be done neatly, in pencil, and on one side of the sheet only. Students may and are welcome to discuss assignments with the instructor and classmates. However, each student must independently complete each assignment. Unless otherwise stated, all homework assignments will be due at the BEGINNING of the class, USUALLY ONE WEEK after the date assigned.
7. Make-up tests will be given only in properly documented cases of serious illness, emergency or unavoidable contingency. In case of illness, the student must present a certificate from his/her physician.
8. Final grades will be assigned based on the following University scale:

90 - 100	A	60 - 69	D
80 - 89	B	00 - 59	F
70 - 79	C		

COURSE CONTENT

Topics:

- Water Supply Systems: water uses and quantities, water characteristics, quality and treatment, design of water distribution systems
- Review of basic hydraulics (energy equation and pipe friction).
- Pressure Conduits: Hydraulics of pressure conduits; forces on pipes; pipe materials appurtenances for pressure conduits; inverted siphons.
- Open Channels: Hydraulics of open-channel flow; measurement of flow; types of channels; appurtenances.
- Surface & Groundwater Hydrology aspects: Occurrence, Hydraulics; Wells and groundwater yield.
- Water Law: common law; state and local water codes
- Reservoir & Reservoir operation including: physical characteristics, yield, capacity, sedimentation, waves, and reservoir clearance.
- Water Resources Planning and Management
- Water Storage Structures: flood mitigation reservoirs
- Drainage Structures

NORTH CAROLINA A&T STATE UNIVERSITY

Department of Civil Engineering

CIEN 362 HYDRAULICS Fall 1994

Course Information

Please keep this information for your reference. 8/22/94

Instructor:	***Dr. Emmanuel U. Nzewi***
Lecture Location:	Mon, Wed: 12:30 -1:45 AM; Room 129, McNair Hall
Office:	503 McNair Hall
Office Hours:	Mon & Wed (See posted Times); Tue 8:30 - 2:30 PM
Telephone:	(910) 334-7737
Computer addresses:	ce360@garfield.ncat.edu and nzewi@garfield.ncat.edu
Textbook:	*Potter & Wiggert.*, Mechanics of Fluids, First Edition, Prentice-Hall, Englewood Cliffs, New Jersey, 1991. **Handouts will also be provided when necessary.**
Reference Texts:	• Morris & Wiggert, *Applied Hydraulics in Engineering*, 2nd Ed., John Wiley, 1972.
Course Description:	To present introductory topics in the field of Hydraulics. Both pressurized and Open channel flow are covered.
Prerequisites;	MATH 231 (Calculus III) & MEEN 335 (Statics)
Computer Usage:	Students should be able to use computer programs on the UNIX/DOS /Mac machines.

Fall 1994 Semester Calendar & REMINDERS

Aug 26 Fri	Last day to ADD a course or receive full credit for DROPPING a course
Aug 26 Fri	Last day to audit a course
Aug 22 Mon	Classes Begin !! -- Start strong & finish strong!
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Nov 23 - 27	Thanksgiving Holidays begin 1:00 PM
Dec 7 Wed	Classes End!
Dec 8 Thurs	Reading day!
Dec 9-16	Final Exams Period
Dec 15 Thur	Final Exam 8 - 10 AM SHARP in Room 129 McNair Hall
Dec 19 Mon	Grades due @3:00 P.M. in Registrar's office

Course Guidelines

1. There will be 2 hour exams and a final exam.
2. Homework assignments will be collected and graded. There will be about eight to twelve assignments during the course of the semester. NO LATE HOMEWORK /ASSIGNMENT WILL BE ACCEPTED (GRADE = 0).
3. The course grade will be determined as follows:

Exam #1	25%
Exam #2	25%
Final Exam	30%
Homework	20%
Total	**100%**

4. Dishonesty will result in a grade of F (or ZERO) for the assignment or test involved.
5. Students are expected to attend all class sessions. The University believes that students themselves are primarily responsible for attendance.
6. Standard 8 1/2" X 11" Engineering paper should be used for homework. Work should be done neatly, in pencil, and on one side of the sheet only. Students may and are welcome to discuss assignments with the instructor and classmates. However, each student must independently complete each assignment. Unless otherwise stated, all homework assignments will be due at the BEGINNING of the class, USUALLY ONE WEEK after the date assigned.
7. Make-up tests will be given only in properly documented cases of serious illness, emergency or unavoidable contingency. In case of illness, the student must present a certificate from his/her physician.
8. Final grades will be assigned based on the following University scale:

90 - 100	A
80 - 89	B
70 - 79	C
60 - 69	D
00 - 59	F

COURSE CONTENT

Topics:

- Properties of fluids
- Hydrostatic pressure and manometry.
- Bernoulli and energy equations for steady flow.
- Energy and hydraulic grade lines
- Headloss calculations
- Momentum principle
- Flow and velocity measurement.
- Pumps
- Branched and looped pipe systems; Hardy-Cross method
- Open channel flow, sub- and super-critical flow
- Hydraulic jump
- Dimensional analysis and Similitude

THE WASTE MANAGEMENT INSTITUTE
NORTH CAROLINA AGRICULTURAL & TECHNICAL
STATE UNIVERSITY

AND

THE HBCU/MI ENVIRONMENTAL TECHNOLOGY
AND WASTE MANAGEMENT CONSORTIUM

PRESENT

THE FIFTH PRE-COLLEGE

ENVIRONMENTAL TECHNOLOGY AND WASTE MANAGEMENT WORKSHOP

NORTH CAROLINA A&T STATE UNIVERSITY
B. C. WEBB HALL AUDITORIUM
WEDNESDAY, JUNE 28, 1995
8:00 A.M. - 12:00 P.M.

OPEN TO THE PUBLIC

FUNDED BY THE U. S. DEPARTMENT OF ENERGY -
SAVANNAH RIVER OFFICE

and

THE HBCU/MI AND ENVIRONMENTAL TECHNOLOGY
AND WASTE MANAGEMENT CONSORTIUM

THE WASTE MANAGEMENT INSTITUTE

AND

THE HBCU/MI ENVIRONMENTAL TECHNOLOGY AND WASTE MANAGEMENT CONSORTIUM

WEDNESDAY, JUNE 28

B. C. Webb Hall Auditorium

8:00 - 8:20	Registration
8:20 - 8:30 Mr. Casters Fosters Advisor Waste Management Institute	Welcome
8:30 - 8:50 Dr. Godfrey Uzochukwu Director and Professor Waste Management Institute NCA&TSU	Waste Management Issues
8:50 - 9:20 *FACILITATORS* Mr. Harvey Campbell Mr. Wilfred Nixon Mr. Michael Murphy Mr. Eric Funderburk	Participant Introductions
9:20 - 9:50 Dr. Jothi Kumar Associate Professor Department of Chemistry NCA&TSU	Solar Detoxification of Wastewater
9:50 - 10:20 Dr. Shoou-Yuh Chang Professor Department of Civil Engineering NCA&TSU	Engineering Designs and Waste Disposal
10:20 - 10:30	Break

WEDNESDAY, JUNE 28

10:30 - 11:00
Dr. Godfrey Ejimakor
Assistant Professor
Agricultural Economics
NCA&TSU

Environmental Justice and Policy

11:00 - 11:30
Mr. Bob Patterson
Safety and Health
NCA&TSU

Environmental Safety

11:30 - 12:00
Dr. Donald McDowell
Associate Professor
Agricultural Economics &
Rural Sociology
NCA&TSU

The Impact of Pollution
on Economic Development

12:00

Adjourn

THE WASTE MANAGEMENT INSTITUTE

AND

THE HBCU/MI ENVIRONMENTAL TECHNOLOGY AND WASTE MANAGEMENT CONSORTIUM

WORKSHOP COMMITTEE

Dr. Shoou-Yuh Chang

Mr. Harvey Campbell

Mr. Wilfred Nixon

Ms. Carolyn Ruff

Ms. Azell Reeves

Dr. Godfrey A. Uzochukwu

THE GREENSBORO AREA MATHEMATICS AND SCIENCE EDUCATION CENTER (GAMSEC)

AND

THE WASTE MANAGEMENT INSTITUTE (WMI)
NORTH CAROLINA AGRICULTURAL & TECHNICAL STATE UNIVERSITY

PRESENT

THE 1ST EARTH AND ENVIRONMENTAL SCIENCE SUMMER INSTITUTE FOR TEACHERS (K-12)

NORTH CAROLINA A&T STATE UNIVERSITY

CARVER HALL 165

June 26 - 30 and July 10 - 14, 1995
8:30 A.M. - 1:30 P.M.

FUNDED BY THE U. S. DEPARTMENT OF ENERGY - SAVANNAH RIVER OFFICE

and

US ENVIRONMENTAL PROTECTION AGENCY

GAMSEC

AND

WASTE MANAGEMENT INSTITUTE
NORTH CAROLINA A&T STATE UNIVERSITY

MONDAY, JUNE 26
(Grades 6-12)

Carver Hall 165

8:00 - 8:30	**Registration**
8:30 - 8:40 Dr. Vallie Guthrie Director GAMSEC NCA&TSU	**Welcome**
8:40 - 9:00 Dr. Godfrey A. Uzochukwu Director and Professor Waste Management Institute NCA&TSU	**Environmental and Waste Management Issues**
9:00 - 9:10	**Break**
9:10 - 11:00 Dr. Robert Williamson Extension NCA&TSU	**Project Learning Tree**
11:00 - 11:10	**Break**
11:10 - 12:30	**Video Presentations**
12:30	**Adjourn**

TUESDAY, JUNE 27
(Grades 6-12)

Carver Hall 165

8:30 - 9:00	Registration
9:00 - 11:00 Dr. Robert Williamson Extension NCA&TSU	Project Learning Tree
11:00 - 11:20	Break
11:20 - 12:30	Hands - on Activity

WEDNESDAY, JUNE 28
(Grades 6-12)

Carver Hall 165

8:30 - 9:00	Registration
9:00 - 11:00 Dr. Robert Williamson Extension NCA&TSU	Project Learning Tree
11:00 - 11:20	Break
11:20 - 12:30	Video Presentations
12:30	Adjourn

THURSDAY, JUNE 29
(Grades 6-8)

Carver Hall 165

8:30 - 8:50
Mr. Broadus Funderburk
Outreach Coordinator
Waste Management Institute
NCA&TSU

Introduction

8:50 - 9:20
Ms. Anne A. Pope
Environmental Engineer
Education and Outreach, USEPA

Environmental Program for Middle Schools

9:30 - 12:00
USEPA Presenters

Air Quality

THURSDAY, JUNE 29
(Grades 9-12)

Carver Hall Auditorium

8:30 - 12:30
Dr. M. R. Reddy
Professor
Natural Resources
NCA&TSU

Tour of Environmental Facilities and Hands-on Activities

FRIDAY, JUNE 30
(Grades 6-8)

Carver Hall 165

8:30 - 12:30
USEPA Presenters

Nuclear Waste

FRIDAY, JUNE 30
(Grades 9-12)

Carver Hall Auditorium

8:30 - 12:30
Dr. Godfrey Uzochukwu
Director and Professor
Waste Management Institute
NCA&TSU

Tour of A&T's Environmental
Studies Laboratory

MONDAY, JULY 10
(Grades K-5)

Carver Hall 105

8:30 - 8:50 Dr. Vallie Guthrie Director GAMSEC NCA&TSU	Welcome
8:50 - 9:20 Dr. Godfrey Uzochukwu Director and Professor Waste Management Institute NCA&TSU	Environmental and Waste Management Issues
9:30 - 10:40 Dr. G. B. Reddy Professor Natural Resources NCA&TSU	Principles of Environmental Remediation
10:40 - 10:50	Break
10:50 12:00 noon	Tour of Environmental Facilities and Hands-On Activities

TUESDAY, JULY 11
(Grades K-5)

Carver Hall 105

8:30 - 8:50 Dr. Vallie Guthrie Director GAMSEC NCA&TSU	Introduction
8:50 - 9:40 Dr. Keith Schimmel Assistant Professor Chemical Engineering NCA&TSU	Engineering Aspects of Environmental Remediation

TUESDAY, JULY 11
(Grades K-5)

Carver Hall 165

9:50 - 10:40 Dr. Shoou-Yuh Chang Professor Civil Engineering NCA&TSU	Engineering Functions of Waste Facilities
10:40 - 12:00 Drs. Chang and Schimmel Professors Civil and Chemical Engineering NCA&TSU	Tour of Environmental Facilities

WEDNESDAY, JULY 12
(Grades K-5)

Carver Hall 165

8:30 - 8:50 Dr. Vallie Guthrie Director GAMSEC NCA&TSU	Introduction
8:50 - 9:40 Dr. Donald McDowell Associate Professor Agricultural Economics NCA&TSU	Environmental Justice
9:40 - 9:50	Break
9:50 - 10:40 Dr. Lanell Ogden Associate Professor Animal Science NCA&TSU	Toxic Elements in the Environment

THURSDAY, JULY 13
(Grades K-5)

Carver Hall 165

8:30 - 12:00 Dr. Godfrey Uzochukwu Director and Professor Waste Management Institute NCA&TSU	Video Presentations and Tour of Environmental Facilities

FRIDAY, JULY 14
(Grades K-5)

Carver Hall 165

8:00 - 8:30	Registration
8:30 - 8:50 Dr. Vallie Guthrie Director GAMSEC NCA&TSU	Introduction
8:50 - 9:20 Ms. Anne A. Pope Environmental Engineer Education and Outreach, USEPA	Environmental Program for Grades K-5
9:20 - 12:00 USEPA Presenters	Air Quality

VITA DATA
1 - 30 - 56

DR. G. A. UZOCHUKWU, PROFESSOR AND DIRECTOR
N.C. A&T State University

Natural Resources and Environmental Design

Waste Management Institute

CITIZENSHIP:
United States of America

EDUCATION:
B.S. (1979) Oklahoma State University
M.S. (1980) Oklahoma State University
Ph.D. (1983) University of Nebraska
Post-Doc (1984) Texas A&M University

ACADEMIC FIELD:
Soil, Earth, and Environmental Sciences

EXPERIENCE:

- **July 1993 - Present (Professor)**

- **July 1989 - June 1993 (Associate Professor)**

- **January 1985 - June 1989 (Assistant Professor)**

  North Carolina A&T State University, Greensboro, NC.
  Has responsibility for providing instruction in the disciplines of earth science, geology, mineralogy, soils, landuse and environmental sciences at both undergraduate and graduate levels. Research responsibility includes investigation of environmental implications of soil and mineral properties for better land use. Involved in interdisciplinary and multidisciplinary research with other scientists in soil environmental processes and ecology

- **January 1984 - December 1984 (Research Associate)**

  Texas A&M University, College Station, Texas. Developed a procedure for identification and study of soil manganese minerals by x-ray diffraction.

ADMINISTRATION:

- 1993 - Present: Director of NC A&T's Interdisciplinary Waste Management Institute

- 1992 - Present: Director of NC A&T's Earth System Science (NASA) Project

- 1993 : Chair. of the Waste Management Institute's Planning Committee

- 1992 - Present: Director of NC A&T's Seismic Station

- 1985 - Present: Developed the earth and environmental science program at NCA&TSU and serves as the program coordinator.

CONSULTING SERVICES:
Media
Chatham Co. (1990 Low level Radioactive Waste Site Selection)
Public School Science Projects
University Science Projects
Community Projects
Local small business

PROFESSIONAL SOCIETIES:
American Society of Agronomy
Carolina Geological Society
Mineralogical Society of America
North Carolina Academy of Science
Soil Science Society of North Carolina
Soil Science Society of America
Clay Mineral Society of America

CERTIFICATION FOR PROFESSIONAL PRACTICE:
Certified Soils Specialist (CSS) - North Carolina

BOARD/COMMITTEE MEMBERSHIPS:
Member of the Technical Review Board of the UNC System Water Resources Research Institute (1991 - 1994)
Member of the Brightwood Elementary School Advisory Council (1993 - present; Chair 1995/96).
Member of the Student Manuscript Contest Committee (American Society of Agronomy, 1994-1996)
Undergraduate Committee Member - Advancement of Minority in Environmental Professions.
Member of Minority Concerns Committee - American Society of Agronomy

PUBLICATIONS:
Slope, N.B., D.T. Lewis, G.A. Uzochukwu, and S.L. Hartung. 1993. Soil Moisture and Clay Measurement of Volcaniclastic Soils of Western Nebraska. Great Plains Research. 3, No. 1. Journal of Natural and Social Sciences 94-107.

Uzochukwu, G.A. 1995. (4th Ed.) Exercises in Earth and Environmental Sciences. (J.T. Ice, ed.) McGraw-Hill Inc. New York. College Custom Series.

Uzochukwu, G.A. and D.T. Lewis. 1990. Volcanic Glass Influence on Selected Soil Properties in Western Nebraska. Soil Sci. Soc. Am. J. 54: 1058-1060

Dixon, J.B., D.C. Golden, G.A. Uzochukwu, and C. C. Chen. 1990. Soil Manganese Oxides. In Boodt et al. Soil Colloids and their Association in Aggregates. Plenum Press, New York: 141-163.

Uzochukwu, G.A. and D.T. Lewis. 1986. Chemical, Physical, and Mineralogical

Properties of Mitchell and Tripp soils in the Nebraska Panhandle. The Agricultural Research Division. University of Nebraska, Lincoln, Research Bulletin 307

Uzochukwu, G.A. and D.T. Dixon. 1986. Manganese Oxide Minerals in Nodules of Two Soils of Texas and Alabama. Soil Science Society of America Journal. 50: 1358-1363.

Uzochukwu, G.A. and D.T. Lewis. 1983. Classification of Two Soils in Medical Textured Sediments on Platte River Terraces in Western Nebraska. Proceedings of the Nebraska Academy of Sciences. Morrill Hall, The University of Nebraska, Lincoln, Nebraska.

Uzochukwu, G.A. 1983. Properties, Genesis and Classification of Soils on Two Geomorphic Surfaces in the North Platte River Valley in Western Nebraska. Ph.D. Dissertation. The University of Nebraska, Lincoln, Nebraska.

Uzochukwu, G.A. and F. Gray. 1981. The Effect of Slope Aspects on the morphological Physical and Chemical Properties of Soils of a Mountainous area of Eastern Oklahoma.

Proceedings of the Nebraska Academy of Sciences. Morrill Hall, The University of Nebraska, Lincoln, Nebraska.

MISCELLANEOUS PUBLICATIONS:

Uzochukwu, G.A. 1995 (Revised). Physical Geology: A New Laboratory Approach. North Carolina A&T State University, Greensboro, North Carolina.

Uzochukwu, G.A. 1989. Exercises in Earth and Environmental Science. North Carolina A&T State University, Greensboro, North Carolina.

Uzochukwu, G.A. 1994.(Revised) Teaching Aid for Interpretation an Use of North Carolina Soils. North Carolina A&T State University, Greensboro, North Carolina.

Nixon, Wilfred. 1994. Clay Mineral Properties of Enon Soil. Science Opportunity Fellowship Report. NCA&TSU and UNC-CH.

Campbell, Harvey. 1994. Clay Mineral Properties of Helena Soil. Science Opportunity Fellowship Report. NCA&TSU and UNC-CH.

WORKSHOPS AND CONFERENCES:

Uzochukwu, G. A. 1994. Strategies for Implementation of Interdisciplinary Waste Management Instruction. Agronomy Abstracts. American Society of Agronomy. Madison, WI.

Uzochukwu, G.A. 1992. Development of Predictive Models for Natural Resource Management Soil Survey Conference, Raleigh, NC.

Uzochukwu, G.A. 1992. Methods of Waste Site Selection and Disposal. Conference Proceedings, ET/WM Workshop. San Juan, PR.

Uzochukwu, G.A. 1992. Portrait of Soils t a Waste Site in North Carolina, Agronomy Abstracts. American Society of Agronomy.

Uzochukwu, G.A. 1991. Waste Sites and Soil Problems in North Carolina. Agronomy Abstracts. ASA-SSSA., Madison, WI.

Uzochukwu, G.A. 1991 Problems Associated with the Selection of Waste Sites in North Carolina. Engineering and Technical Conference on Waste Management, San Juan, Puerto Rico.

Uzochukwu, G.A. 1990. Environmental Implication of Expanding Minerals at a Low Level Radioactive Waste Disposal Facility. Agronomy Abstracts, p. 322. American Society of Agronomy, Madison, Wisconsin.

Uzochukwu, G.A., M.R. Reddy, R.J. McCracken and J.M. Bradford. 1989. Mineralogy and Strength of Three Piedmont North Carolina Soils. Agronomy Abstracts, p. 322. American Society of Agronomy, Madison, Wisconsin.

Uzochukwu, G.A. 1988. Energy Waste Disposal in Geologic Repositories. Center for Energy Research and Training Workshop. North Carolina A&T State University, Greensboro, NC 27411

Uzochukwu, G.A., M.R. Reddy, and S.J. Dunn. 1988. Solution to the Problem of Coincidence of Two Manganese Mineral X-Ray Peaks. Agronomy Abstracts, p. 309, American Society of Agronomy Madison, Wisconsin.

Uzochukwu, G.A. 1987. Manganese Oxide Minerals in Two North Carolina Piedmont Soil Nodules. Agronomy Abstracts, p. 276. American Society of Agronomy, Madison, Wisconsin.

Dixon, J.B., D.C. Golden, G.A. Uzochukwu, and C.S. Chen. 1986. Soil Manganese Oxide Minerals. Soil Colloids, Structures and Associations in Soil Aggregates, NATO workshop. Ghent, Belgium, September 3-7, 1984. In cooperation with ISS Working Group Studies of the Nature and Properties of Soil Science Colloid Surfaces.

McCracken, R.J. and G.A. Uzochukwu. 1986. Soil Information Resources and Technologies for Solving Waste Disposal Problem. 1986. Conference on Environmental Technology, Chapel Hill, North Carolina.

Uzochukwu, G.A. 1986. Toxic Metals Accumulation in Soil Nodules. Agronomy Abstracts. p. 37. American Society of Agronomy, Madison, Wisconsin.

Uzochukwu, G.A. and G.B. Reddy. 1986. Heavy Metals Accumulation in Selected Forages of Piedmont Region of North Carolina Agronomy, Madison, Wisconsin.

Uzochukwu, G.A. an J.B. Dixon. 1984. Manganese Oxide Minerals in Concretion of Two Soils of Texas and Alabama. Agronomy Abstracts. p. 276. American Society of Agronomy, Madison, Wisconsin.

Uzochukwu, G.A. and D.T. Lewis. 1983. Genesis and Classification on Soils in Medium Textured Sediments on Platte River Terraces and Piedmont Surfaces in Western Nebraska. Agronomy Abstracts. p. 193. American Society of Agronomy, Madison, Wisconsin.

FUNDED PROGRAMS:

National Science Foundation (PI) $18,000
Investigation of near surface and subsurface geologic condition

Industry Cluster (PI) $500
Particle size distribution of geologic materials

DOE (Co-PI) $99,000
Oak Ridge Assoc. Universities
Mineralogical characteristics of rock salts and clays

USDA (Co-PI) $70,000
Evaluation of S.E. soil properties for water erosion prediction

NSF/UNC Chapel Hill (PI) $51,000
Career Access in Earth Ocean, and Environmental Science

DOE (Co-PI) $250,000
Academic Partnership Program in Environmental Technology and Waste Management

USDA (PI) $152,166
Instructional Resources and Outreach Program

NASA (PI) $284,832
Development of Predictive Models for Natural Resource Management

NSF/UNC-CH (PI) $73,000
Career Access Program for Under-represented Minority Groups

USEPA (PI) $16,500
Environmental Internship for undergraduate students

USDOE-SR (PI) $262,070 installment of $1.5 million
Infrastructure Support for the Waste Management Institute at NCA&TSU

HONORS/AWARDS

1991 Amoco Foundation Teaching Excellence Award (**Teacher of the Year**)

Cited in the 1992 WHO'S WHO Environmental Registry for Achievement in Environmental Industry

Cited in the 1994 WHO's WHO Among America's Teachers

COMMITTEE ASSIGNMENTS:

Thesis committee - Depts. of Natural Resources and Civil Engineering

Graduate committee - Dept. of Natural Resources

Readmission and Retention Committee - University

Energy Conservation Committee - University

Waste management Institute Advisory Committee - University

Academic Affairs Administrative Council - University

DOE - Funded Chair - College of Engineering

Strategic Planning Committee (co - chair) - Dept. of Natural Resources

Waste Management Institute Symposium Committee - University

Undergraduate Student Advisor and Earth & Envir. Sci. Coord. - Natural Resources